§3. Development of Real-time Monitor of the Waveguide Transmission Power for ECH

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Electronic Cyclotron Heating is one of the main methods to produce and heat the Large Helical Device (LHD) plasma. ECH system has been operated during third cycle experimental campaign with 6 sets of gyrotron and transmission system. We have monitored the state of gyrotron oscillation by detecting leakage microwave power around the reflecting mirrors. The signal from this monitor gives only limited information of the states of gyrotrons, and is not reliable enough to use it as an interlock source. Moreover, reliable real-time oscillation and injection power monitor is required for the analysis of the plasma experimental data. We have started the development of reliable real-time power monitor, which can be readily installed on the present transmission line.

Fig. 1 shows the block diagram of designed power monitor. A part of the power reflected at the miter bend is coupled to the fundamental waveguide through the coupling holes with cut-off diameter. The rectangular trench on the backside of the mirror naturally forms fundamental waveguide. The wavelength in the fundamental waveguide is designed to be the same as that along the mirror surface in free space, to keep the directivity high. The distance between the holes is about half wavelength to get rid of undesired diffraction. In order to reduce the sensitivity at harmonic angles, the diameters of cut-off holes are controlled as raised cosine. The electric field direction in the fundamental waveguide determines the sensitive direction of polarization of this monitor. Actually, we have designed and produced E-bend and H-bend power monitor by setting the direction of the electric field in the fundamental waveguide perpendicular and parallel to the reflecting mirror surface.

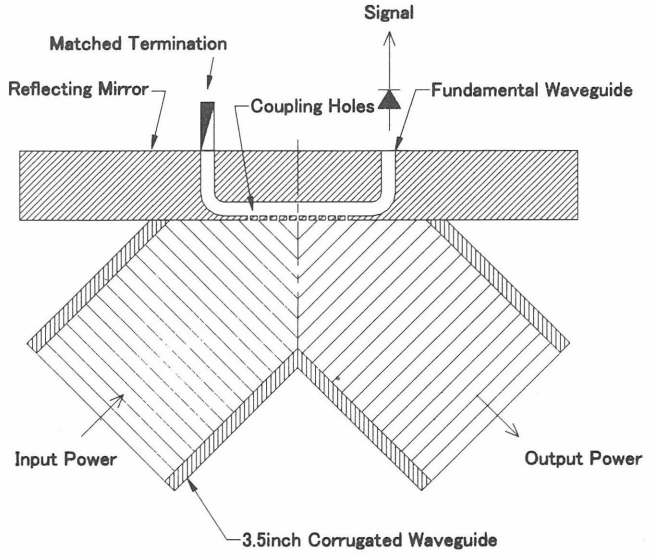

Fig.1. A schematic diagram of microwave monitor attached on the reflecting mirror of miter bend.

Fig. 2 is a photograph of high power test setup. Here, the E-bend monitor is installed. The output signal is cross calibrated by the power measurement at the dummy load which is installed on the other end of waveguide. Fig. 3 shows the dependence of the output signal from a monitor on the transmitted power measured at the dummy load. By adjusting the attenuator in front of the detector, it is possible to give the real-time signal that is proportional to the transmitted power. This monitor is tested up to 300ms at 350 kW. After the feasibility test at longer pulse and higher power, this type of power monitors are planned to be installed on each ECH transmission line of LHD.

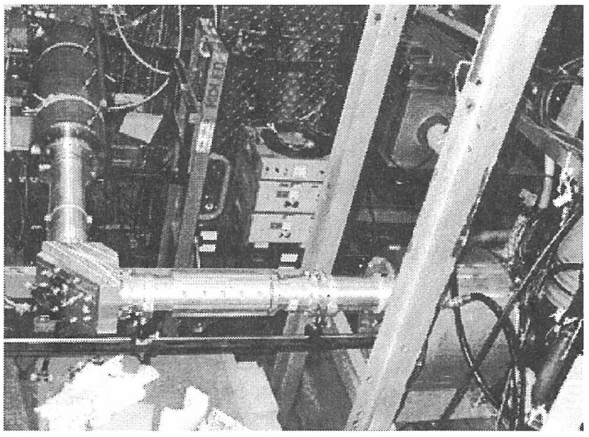

Fig.2. Photograph of high power test of Miter bend

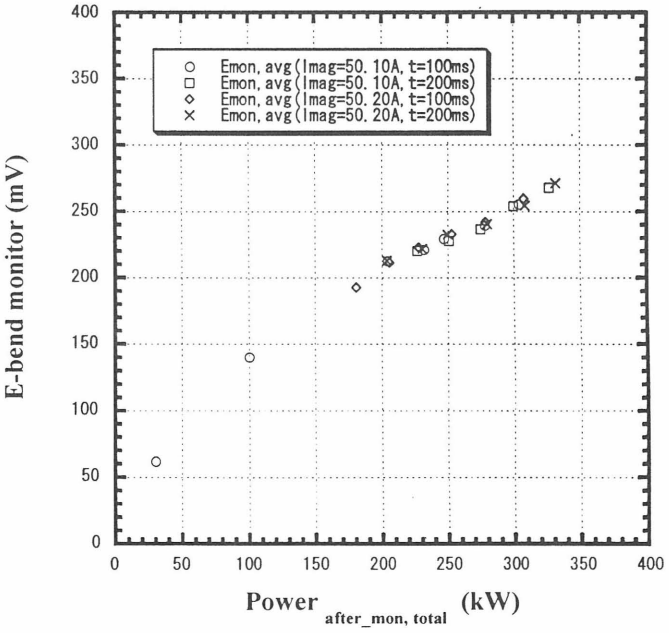

Fig.3. The dependence of the output signal on the transmitted power measured at the water dummy load.